

SECTION 4

METHODS

This section provides a summary of both operational and sampling/analysis methods used during this investigation at the FLB, AALB and Control sites (Quality Assurance Project Plan, 2003).

OPERATIONAL METHODS

Moisture Addition

Moisture addition for this project was primarily leachate addition to the FLB and AALB test cells. It was achieved via gravity-fed injection through the horizontal piping or trench systems so as to increase significantly the moisture content of these wastes when compared to the control cells. Rates of gravity-fed moisture addition varied from approximately 5 to 80 gallons per minute.

Excessive moisture addition can result in leachate seeps or breakouts, and reduced performance of landfill gas collection wells and trenches. Consequently, moisture addition events included site monitoring by the landfill operator. Similarly, operator judgment was used to reduce such moisture additions during periods of precipitation or to increase moisture addition quantities during periods when the waste mass appeared to be drier. The amount and timing of moisture addition were established through a series of trial events so as to increase volumes added to the waste mass without compromising the leachate containment or landfill gas collection systems. Field procedures and practices used for moisture addition at Outer Loop are discussed in Section 6 - Field Observations.

Facultative Landfill Bioreactor (FLB) --

Leachate collected from Unit 5 is recirculated through an on-site Sequential Batch Reactor (SBR) containing fixed chemolithotrophic bacteria that reduce the ammonium level by converting it to nitrate/nitrite. The leachate remains in contact with nitrification microorganisms for sufficient time to nitrify to achieve an ammonia concentration of less than 50 mg/L. The nitrified aqueous product is then pumped to a holding tank before being returned to the FLB through a series of gravity-fed horizontal trenches. These trenches were constructed in the surface of the landfill after waste placement was complete. Other sources of liquid may be used to supplement the leachate, including water from the under drain or sediment pond, or other liquid sources permitted by the landfill facility permit.

Aerobic-Anaerobic Landfill Bioreactor (AALB) --

Leachate and other moisture quantities are applied to the surface of the Unit 7 AALB units and through perforated piping manifolds connected to four tanks used to accumulate liquids from various sources. These sources have included Unit 7 leachate, various commercial liquids, surface water, and under drain water. The tanks' gravity feed to both the surface and buried manifolds; the surface manifold was moved on an ongoing basis to different locations of the

waste mass so as distribute moisture more evenly onto the waste (as determined by the landfill operator). In practice, moisture quantities were added to the lift of waste immediately below the lift of waste being aerated.

Air Addition

Aeration of the AALB unit was initiated within 30 days of completing a new lift of waste and was accomplished on an intermittent basis. Prior to commencing, moisture was added to the working face of the lift to be aerated. Aeration was performed after a lift of waste was placed to cover the aeration piping and the prescribed moisture addition was completed. Air addition was achieved through the horizontal piping installed between the lifts of the landfill, primarily using a blower at a pre-established rate between 200 to 1,000 scfm (Hater et al. 2001), supplemented on occasion with an air compressor. The rate and duration of air addition was dependent on the waste lift and, in particular, waste temperature. The air pressure across the header was balanced using a pressure gauge once the blower had been operational for 24 hours. The aeration face was watered on an approximate weekly basis.

Aeration was performed over a period of approximately 30 to 60 days or until waste temperature reached 60°C. Aeration times generally varied with:

- food content of waste;
- moisture content of incoming waste and evaporation rate; and
- ambient air and blower air temperature.

To assess the progress of the aerobic composting stage, ongoing monitoring was performed for odors (subjective), landfill gas composition (field instrument), and waste temperature (in situ probes). These parameters provide both information on when to reduce or terminate the air addition, and also as a safety procedure to avoid subsurface fires. For example, changes in landfill gas composition, meaning a decrease in methane content and/or a rise in carbon monoxide content, could be indicative of subsurface fire conditions.

Waste temperature rise was used as the key measure to stop or reduce air addition. If a waste temperature probe reached 80°C, or if after reaching 60°C, a temperature probe increases by 10°C or more during any 48-hour period, air addition would be terminated. See also Section 6 - Field Observations.

SAMPLING AND ANALYTICAL METHODS

The following sampling and analysis methods were applied to all of the tested landfill cells. Methods used during this investigation were concordant with EPA Standard methods contained within SW 846.

Sampling Frequency

An extensive program for sampling was developed for this project. A summary of sampling frequency is provided below, one sample was taken for each parameter at the given frequency from each of the locations: FLB 5.1, FLB 5.2, Control 7.3A, Control 7.3B, AALB 7.4A and AALB 7.4B, with the exception of those taken from the Municipal Solid Waste (MSW). See Field Measurements section for further discussion of the Waste Settlement protocol.

Sampling locations are discussed herein and were intended to reflect representativeness over the entire cells under investigation. For example, each cell's leachate drains to a central sump, samples collected at sumps were therefore assumed to be representative of the entire cell. Similarly, sampling from landfill gas extraction wells and soil boring locations were assumed to represent cell and subcell on an ongoing basis. Generally, samples were taken from central locations within cells so as to avoid edge effects.

TABLE 4-1. SAMPLING FREQUENCIES IN MATRICES OF INTEREST

MATRIX: Leachate		MATRIX: Municipal Solid Waste	
PARAMETER	FREQUENCY	PARAMETER	FREQUENCY
Head on Liner	Continuous	Oxygen Reduction Potential	Daily (up to 250)
Leachate Production	Continuous	Temperature	Daily (up to 250)
Chemical Oxygen Demand	Monthly	Waste Settlement	See Field Measurements
Biochemical Oxygen Demand	Monthly	Cellulose/lignin	30 samples annually
Ammonia-nitrogen	Monthly	Organic Solids	30 samples annually
o-Phosphate	Monthly	Biochemical Methane Potential	30 samples annually
Total Phosphorus	Monthly	Waste Moisture	30 samples annually
Nitrate-nitrogen	Monthly	Appearance	30 samples annually
Nitrite-nitrogen	Monthly	pH	30 samples annually
Total volatile organic acids	Monthly	MATRIX: Landfill Gas	
Temperature	Monthly	LFG flow/production	Weekly
pH	Monthly	CH ₄ , CO ₂ , O ₂ Field	Weekly
Conductance	Monthly	CH ₄ , CO ₂ , O ₂ Summa	Quarterly
Volatile Organic Compounds	Quarterly	Non-methane organic compounds	Quarterly
Semi-Volatile Organic Cmpds	Quarterly	Hazardous Air Pollutants	Quarterly
Total Kjeldahl Nitrogen	Quarterly	Surface emission monitoring	Twice Quarterly
Total Dissolved Solids	Quarterly		
Sulfate	Quarterly		
Chloride	Quarterly		
Potassium	Quarterly		
RCRA Hazardous Metals	Quarterly		

Field Sampling Techniques

Specific sampling procedures have been developed by the EPA and vary with the sample matrices and specific analyses. The types of containers, methods of preservation and holding times are identified in Table 4.2.

Leachate --

Leachate samples were taken at the drain sump areas for Units 5.1 and 5.2, 7.3A and 7.3B, 7.4A and 7.4B. Samples were obtained at regular time intervals at one sampling location. Leachate samples were collected directly from the tap or port on the riser pipe. This port is located at the point near where the leachate riser daylights to surface. Leachate was pumped from the sump through the riser pipe and collected from the valved port. Switching the riser pump from automatic mode to hand mode (essentially turning the pump off) prior to sampling was shown in subsequent sampling events to be an effective procedure for obtaining an adequate volume of leachate.

Leachate samples were collected in the following sequence: COD, BOD, volatile organic acids, pH, temperature, VOCs, SVOCs, TKN, ammonia-N, nitrate-N, nitrite-N, total metals (including potassium), o-phosphate, total phosphate, chloride, sulfate, TDS and conductance. To obtain a representative sample, effluent was purged prior to collecting the actual sample. The purge volume was estimated by multiplying the time the sample line was open by leachate flow rate (30 gal/min) and recorded on the Leachate Sampling Information Form.

Municipal Solid Waste (MSW) --

Solid waste samples were collected annually at systematically chosen boring locations. The cell was divided into six sections; each section was divided into 3x3 square meter grids and a square randomly chosen within a grid as the boring location for that section. The equivalent boring location was used for sampling in the remaining sections. The edges of the cell were not sampled. When drilling could not be initiated or completed for whatever reason in a selected location, a randomly selected square adjacent to the original location was selected, but only for that section where drilling was incomplete.

A drill rig equipped with a 3-foot diameter bucket auger was used to sample each location in 10-foot vertical sections. One representative sample, consisting of a 10 to 20 gallon composited aliquot, was collected for each section. The initial 10 feet of material generally was discarded as it usually contained significant quantities of soil. As the boring advanced, each 10-foot section was extracted from the auger and the appearance and temperature of the waste recorded. At least 30 baseline waste samples were collected from cells in Unit 5 and Unit 7.3 in 2000. Six baseline samples were collected from 7.4A in November 2001 and six from 7.4B in February 2002. Additional samples were collected from all cells in October 2002. More than 30 for Unit 5 cells 5.1A and 5.2B, only 23 for cells 7.4A and 7.4B, and more than 30 for cells 7.3. The reason for this is six borings are placed in each cell. Waste samples are collected for each 10-ft increase in depth as the boring is advanced. The number of samples was dependent on the depth of the boring.

The composite waste samples were sealed in plastic bags and placed in a cooler for shipment to the laboratory. These included samples for organic solids, pH, moisture content, biochemical methane potential, and cellulose/lignin ratio at the frequency designated.

Temperature and ORP of the in-place MSW were monitored by type K-thermocouples (Hanna Model No. HI 766 C1). The data communications/gathering system that the probes are connected to currently record the temperature or ORP reading for each probe, once every 30 minutes. Probes returning erratic temperature readings, based on historic temperature control charts, were investigated and the erratic results flagged.

Landfill Gas --

Gas monitoring was done at the installed gas monitoring point within each cell to monitor activity within the landfill bioreactors and control areas. Information recorded for gas sampling was logged on a Gas Sampling Information Form.

Field monitoring was performed using a GEM 2000 instrument (see Field Measurements) on a weekly basis (see Field Measurements below). Samples were collected for laboratory analysis of methane, carbon dioxide, and oxygen by EPA Method 3, non-methane organic compounds (NMOCs), by EPA Method 25C, and volatile organic hazardous air pollutants (HAPs; Appendix J) by Compendium Method TO-14 on a quarterly basis. These samples were collected in 6-liter SUMMA[®] passivated stainless steel canisters at the gas monitoring point.

Preservation and Handling

Samples collected for laboratory analysis were transported to the lab within 24 hours via an overnight shipping company. Samples requiring cooling for purposes of preservation were packaged in coolers and maintained at 4°C using crushed ice. Ice was packaged in large Ziploc baggies to prevent leakage onto sample containers. The laboratory was contacted prior to the day of shipment. The laboratory recorded the shipment temperature (of a temperature blank) upon arrival and significant variances in temperature (i.e. greater than 4°C) were immediately reported to the WMI project Co-Principal Investigator responsible for field activities.

Project personnel for field activities completed a sample collection narrative form, a record of activities carried out by the sampling team. The team member responsible for the sampling project completed the narrative and it traveled with the Chain of Custody (COC). The instructions laid out in the Project QAPP for the completion of the COC, sample handling and storage, and the transfer of sample custody were adhered to at all times. The sample collection information was also recorded on an analytical data sheet for field-testing parameters such as pH, specific conductance, gas surveys etc.

Samples collected for laboratory analysis were identified with standard labels attached to the sample containers. The standard format detailed in the Project QAPP was utilized to uniquely identify all samples. All field documentation and project logbooks were maintained according to the QAPP (Quality Assurance Project Plan, 2003), which is included as Appendix B.

TABLE 4-2. CONTAINERIZATION, PRESERVATION AND HOLDING TIMES

PARAMETER	SAMPLE VOLUME & CONTAINER	PRESERVATION	MAX. HOLDING TIME
Inorganic Tests			
Ammonia-nitrogen	500ml*, P, G. ¹	Cool 4°C, H ₂ SO ₄ to pH<2	28 days
BOD	1000ml, P, G.	Cool 4°C	48 hours
COD	1000ml, P, G. ¹	Cool 4°C, H ₂ SO ₄ to pH<2	28 days
Conductance (leachate)	P, G.	None required.	Analyze immediately.
Chloride	500ml, P, G.	None required	28 days
Potassium	500ml, P, G.	Field acidified to pH<2 with HNO ₃	28 days
Kjeldahl Nitrogen	1000ml, P, G. ¹	Cool 4°C, H ₂ SO ₄ to pH<2	28 days
RCRA Metals	1000ml, P, G. ¹	Field acidified to pH<2 with HNO ₃	6 months (Hg 28 days)
Nitrate-nitrogen	1000ml, P, G.	Cool 4°C	48 hours
Nitrite-nitrogen	1000ml, P, G.	Cool 4°C	48 hours
o-Phosphate	500ml, P, G.	Cool 4°C, filter in lab if necessary	48 hours
Total phosphorous	500ml, P, G. ¹	Cool 4°C, H ₂ SO ₄ to pH<2	28 days
Total dissolved solids	500 ml, P, G.	Cool 4°C	7 days
Temperature (leachate)	P, G.	None required.	Analyze immediately.
pH (leachate)	P, G.	None required.	Analyze immediately.
pH (waste)	1000ml wide-mouth, P, G.	Cool 4°C	7 days
Moisture (MSW)	1000ml wide-mouth, P, G.	Cool 4°C	28 days
Sulfate	50ml, T, P, G.	Cool 4°C	28 days
Specific Conductance	500ml, P, G.	Cool 4°C	28 days
Organic Tests			
Organic solids	Double-wrapped plastic garbage bag. ²	Cool 4°C	21 days
Cellulose:lignin	Double-wrapped plastic garbage bag. ²	Cool 4°C	28 days
BMP	Double-wrapped plastic garbage bag. ²	Cool 4°C	21 days
Volatile organic acids	8oz. Amber glass, Teflon-lined septa	Cool 4°C	10 days
VOC	3x40ml glass, Teflon-lined septa	Cool 4°C, no headspace	7 days
SVOC	2x11 Amber glass, Teflon-lines septa	Cool 4°C	Extract – 7 days Analyze – 21- 40 days
Microbial studies	500ml P, G Sterile bag	Cool 4°C	24 hours
CH ₄ , CO ₂ , O ₂	6-liter, summa	Not required	7 days

*ammonia sample taken from COD bottle

¹Sample bottles will be sufficient volume to prevent sample loss due to effervescence upon acidification.

²Wrapped samples placed in polyethylene trays with lids and these filled trays are then placed in a (un-cooled) plastic bin.

³This study was performed in addition to the requirements of the QAPP.

P – Plastic

G – Glass

T – Teflon

Sources: SW 846 Methods, 40 CFR 136, and Standard Methods for the Examination of Water and Wastewater.

Analytical Methods

A set of critical and non-critical parameters was established for each matrix. The methods used to measure each of these are presented in the following tables (Analytical Method References 14 to 18).

TABLE 4-3. ANALYTICAL METHODS FOR LEACHATE

CRITICAL		NON-CRITICAL	
PARAMETER	METHOD	PARAMETER	METHOD
Chemical Oxygen Demand	410.4 (C)	VOC	8260 (B)
Biochemical Oxygen Demand	405.1 (C)	SVOC	8270 (B)
Temperature	Cole-Parmer Thermocouple*	o-Phosphate	365.2 (C)
pH	Field electrode*	Total Phosphorus	365.2 (C)
Volatile Organic Acids	Microbial Insights SOP	Total Kjeldahl nitrogen	351.2 (C)
		Total dissolved solids	160.1 (C)
		Sulfate	300.0 (A)
		Chloride	300.0 (A)
		Potassium	6010 (B) (prepared according to 3005)
		Conductance	Field electrode*
		RCRA Haz. Metals	6010/7470 (B) (prepared per 3005)
		Ammonia nitrogen	350.1 (C)
		Nitrate nitrogen	353.2 (C)
		Nitrite nitrogen	353.2 (C)
		Head on Liner	Pressure Transducer*
		Leachate Production	Totalizing Flow Meter*

TABLE 4-4. ANALYTICAL METHODS FOR MUNICIPAL SOLID WASTE

CRITICAL		NON-CRITICAL	
PARAMETER	METHOD	PARAMETER	METHOD
Waste Temperature	Cole Parmer Thermocouple*	Oxidation-reduction Potential	Field ORP Electrode*
Waste Settlement	GPS survey*	Cellulose:lignin ratio	ASTM E-1758-95/Barlaz (R&D Method)
Organic Acids	Barlaz R&D Method	Appearance of Waste	Field Observation*
Moisture Content	Barlaz R&D Method		
pH	US EPA 9045C		
Biochemical Methane Production	Barlaz R&D Method		

TABLE 4-5. ANALYTICAL METHODS FOR LANDFILL GAS

CRITICAL		NON-CRITICAL	
PARAMETER	METHOD	PARAMETER	METHOD
CH ₄ , CO ₂ , O ₂	GEM 2000*	Surface Emission Monitoring	NSPS/FID mod. Method 21*
CH ₄ , CO ₂ , O ₂	Method 3C	Non-Methane Organic Carbon	EPA Method 25C
Gas Collection	Orifice plate*	Hazardous Air Pollutants	Compendium Method TO-14
Gas Volume	GEM 2000*		

* Field Measurements.

Field Measurements

Equipment used for field measurements was calibrated according to manufacturers' instructions.

In-Situ Municipal Solid Waste Temperature and ORP --

Temperature and Oxidation Reduction Potential (ORP) of the in-place waste were monitored by type K thermocouples (Hanna Model No. HI 766 CI) wire connected to a standard Cole-Parmer thermocouple panel meter on the surface. Temperature and ORP readings were made on a daily basis per cell. No calibration was required.

Leachate Temperature, pH and Conductance --

Leachate temperature was measured using a Hanna Instruments Model HI 991301 pH/conductance/temperature probe on a monthly basis. Calibrations were performed per the manufacturer's specifications.

A 500-ml or other suitable, clean, container was used to collect a sample of leachate from the same sampling port used for leachate quality sampling, immediately after collection of the quality samples. Each parameter was measured from the same sample.

The pH meter was capable of measuring pH to +/- 0.002 units. The probe was calibrated before use each time using three buffer solutions that bracketed the expected pH. Accuracy was determined by re-measuring one of the three buffer solutions as a sample. The instrument had a temperature accuracy of $\pm 0.2^{\circ}\text{C}$ and resolution of 0.1°C . Though the measurement was not in-situ, it was typically made within 30 minutes of sample collection.

An Accumet conductivity cell (Fisher Scientific, Cat No. 13-620-166) with a measurement range of 1000 to 200,000 $\mu\text{S}/\text{cm}$, a cell constant (K) of 10.0cm^{-1} and accuracy of +/-0.5 percent was used to make the measurements. The probe was calibrated with standard solution of 12,880 $\mu\text{S}/\text{cm}$ ($\mu\text{mho}/\text{cm}$) @ 25 degrees C (Hanna Instruments, Cat No. HI 8030L). The cell had a one point automatic calibration, though several standard solutions were used to check the range. Leachate conductivity measurements typically fell in the 4-18 mS/cm range.

Head on Liner and Leachate Production --

An in-place pressure transducer measured the head on the landfill liner and leachate production was quantified with a factory-calibrated totalizing flow meter (one per cell).

Landfill Gas Composition and Volume --

A factory-calibrated orifice plate was used to measure the volume of gas collected by the landfill gas collection system. Gas temperature was measured using a Reotemp bimetal thermometer permanently fixed to the gas header, metering station piping, or gas well near the orifice plate. The thermometer is of stainless steel construction, approximately 3-inch diameter, with a dial direct read face.

Gas field analyses were performed for methane, carbon dioxide, and oxygen using a GEM 2000, and in accordance with procedures given in EPA Method 3C. This instrument is a portable field gas analyzer and uses a self-compensating infrared detector. The instrument was calibrated prior to use per manufacturer specifications using 50:35:0:15 CH₄:CO₂:O₂:N₂ and 0:0:4:96 CH₄:CO₂:O₂:N₂ gas mixtures. Additionally, the calibration was checked again after sample measurements with these gas mixture standards. Calibration gases for the GEM 2000 were obtained from CES Landtec and included concentrations that bracket the expected measured concentration and a "zero" gas (e.g. nitrogen). Concentration readings for carbon dioxide and methane had to be within 15 percent of the actual concentration or sample duplicate; the tolerance for oxygen was \pm 30 percent. Zero gases registered at no greater than 5 percent of the span of the instrument.

After calibration, the instrument was connected to a gas sampling port using flexible plastic tubing. Gas was drawn into the instrument by an internal pump and analyzed. Results were date and time stamped and data logged by the instrument. Gas standards for CH₄, CO₂ and O₂ were analyzed twice daily on the day of sampling to evaluate accuracy objectives. Gas volume measurements were made by electronically logging three consecutive measurements of gas quality (methane, carbon dioxide, oxygen, and balance gas) and flow (differential pressure, static pressure, gas temperature, and flow rate) to the GEM 2000 for each sample point. The mean value for each of these measurements was recorded as the value for each parameter of interest.

Surface Emissions Monitoring --

Surface emissions monitoring was performed for methane using the field instrument CEC - Landtec SEM-500. This is a hand held portable flame ionization detector used to monitor surface emissions at landfills. The instrument was calibrated prior to use according to the manufacturer's specifications.

Surface emissions monitoring was performed in accordance with the requirements specified by the New Source Performance Standards (NSPS) and Emission Guidelines (EG) for municipal solid waste landfills in 40 CFR 60.755. Methane concentrations were measured within 5 to 10 cm (2 to 4 in) of the landfill surface using the field instrument. Methane concentrations were measured following the procedures in EPA Method 21, except that "methane" replaced all

references to "volatile organic compounds" (VOC) and the calibration gas was 500-ppm methane in air [§ 60.755(d)]. Methane surface concentrations were monitored around the perimeter of the collection area and along a pattern that traverses the landfill at 30 -meter intervals. In addition, prescribed monitoring included taking measurements where visual observations indicated elevated concentrations of landfill gas (e.g., distressed vegetation, cracks or seeps in the cover).

Waste Settlement --

Surface settlement of the fill was monitored quarterly through Global Positioning Survey (GPS) measurements of elevation. The number of measurements taken per quarter is tabulated below. Unit 5 cells 5.1 and 5.2 are each comprised of two subcells, with each subcell having 20 GPS points.

TABLE 4-6. NUMBER OF GPS POINTS PER LOCATION

LOCATION	NUMBER OF GPS POINTS
FBL 5.1 (A&B)	40
FBL 5.2 (C&D)	40
Control 7.3A	20
Control 7.3B	20
AALB 7.4A	20
AALB 7.4B	20

GPS measurements were performed using the Trimble model 4800. Sampling points within a cell were selected according to the following criteria:

1. Every sampling event was initialized from a known point and within a ± 5 cm span for the horizontal and vertical coordinates of the known point. If sampling within a cell was interrupted, the system was reinitialized from the known point before sampling was resumed.
2. Sampling was initiated if the root mean square reading from the system was less than or equal to 10.
3. The positional dilution of precision (a measure of the relative dispersion of satellites in the sky) reading was less than or equal to 6 before the system was initialized.

In addition to the plots described above, standard high and low points and contours were measured. One of every 20 points measured by GPS was randomly selected and re-sampled. These methods were used to confirm that the positional accuracy of the GPS readings was sufficient to meet the analytical needs of the investigation (including conformance with the QAPP), and that the GPS measurements made were accurate, reliable, and comparable.

In addition to GPS measurements and survey data, settlement plates were installed to provide a localized indication for refuse settlement within the landfill test cells. Settlement plates were placed in the proximity of wells and trenches to measure the surface movements during the study. The top elevation of each plate was surveyed prior to initiation of moisture addition.

Figures 4-1 and 4-2 provide GPS and settlement plate locations for Units 5 and 7, respectively.

Fugitive Gas Emissions Study --

Sampling and analytical methods involved with measuring fugitive gas emissions at the Outer Loop Landfill are presented in Appendix E.

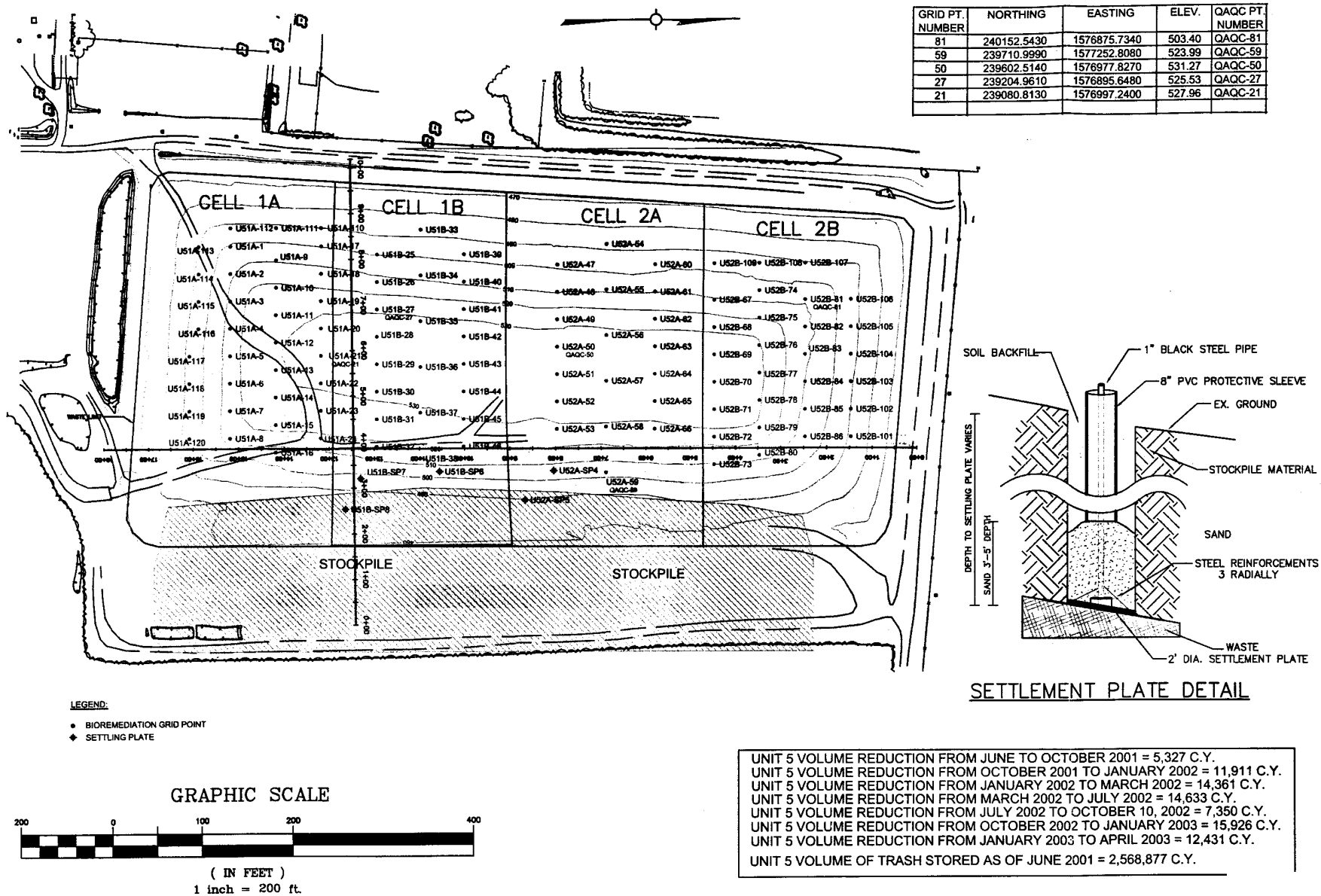
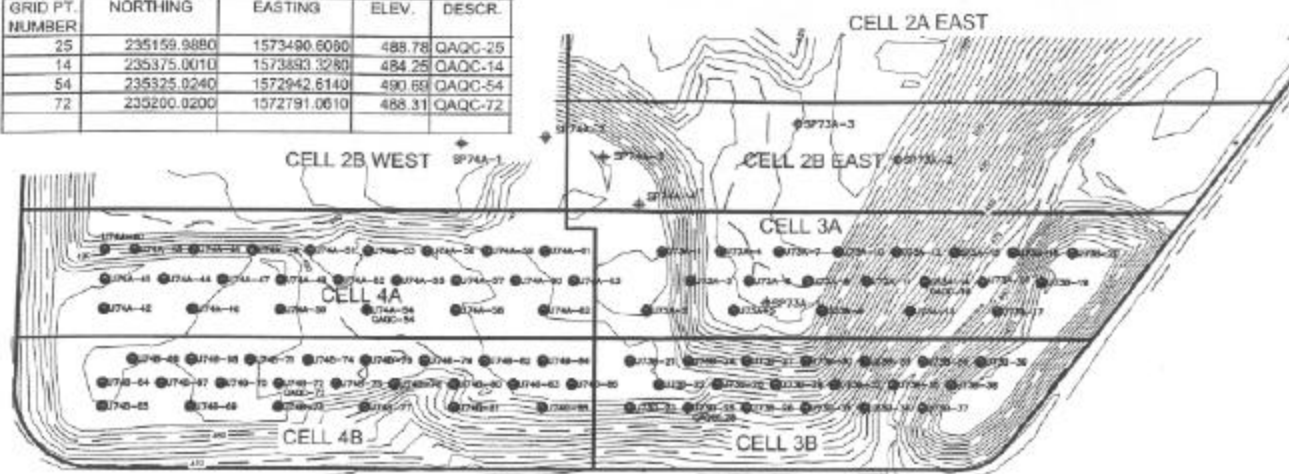


Figure 4-1. Unit 5 GPS Point and Settlement Plate Locations



GRID PT. NUMBER	NORTHING	EASTING	ELEV.	DESCR.
25	235159.9880	1573490.6080	488.78	QAQC-25
14	235375.0010	1573893.3280	484.25	QAQC-14
54	235325.0240	1572942.6140	480.69	QAQC-54
72	235200.0200	1572791.0610	488.31	QAQC-72



BIO-REACTOR VOLUME SUMMARY:
 CELL 2: 6,433 C.Y.
 CELL 3: -725 C.Y.*
 CELL 4A: 95,829 C.Y.
 CELL 4B: 37,068 C.Y.
 * Negative Volume indicates Settlement.



LEGEND:
 ● BIOREMEDIATION GRID POINT
 ✕ SETTLING PLATE

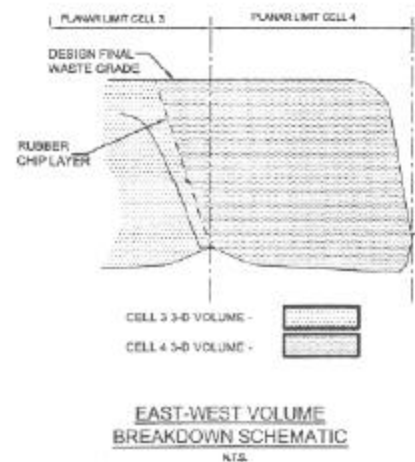
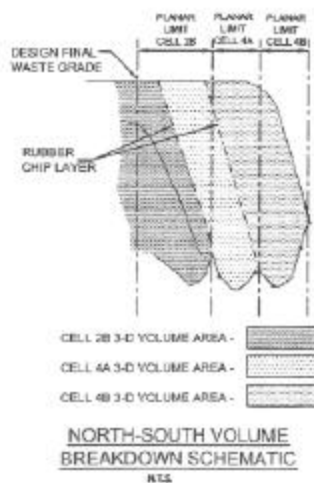
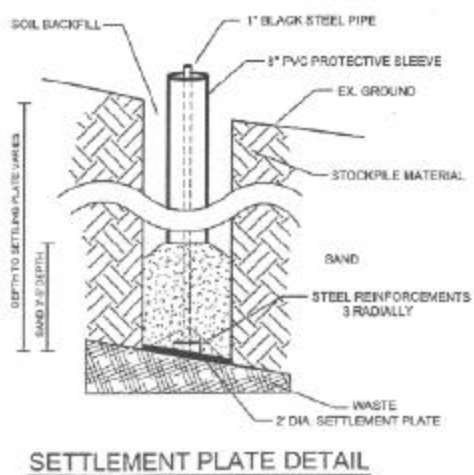


Figure 4-2. Unit 7 GPS Point and Settlement Plate Locations